

Claims

1. A device for producing high pressure in a fluid, comprising a piston which is movable in a cylinder, a high pressure chamber which is located in front of the piston inside the cylinder, and a valve, which device includes
  - a cylindrical hollow piston,
  - a valve member which is guided by the hollow piston and is mounted so as to be axially movable against the hollow piston,
  - a stop means on the hollow piston which holds the valve member to the hollow piston, and
  - a defined sealing surface at the inlet end of the valve member.
2. A device according to claim 1, including
  - a cylindrical hollow piston with a stop on the outside of the hollow piston in the region of its outlet end,
  - a cylindrical valve member which is guided and mounted so as to be axially movable directly at the outlet end of the hollow piston,
  - a plurality of undercut snap hooks mounted on the valve member, and
  - a defined sealing surface at the inlet end of the valve member on the flat outlet end of the hollow piston.
3. A device according to claim 1 or 2, including
  - an encircling, preferably turned or shaped groove or a shaped taper with an encircling, outwardly funnel-shaped edge as the stop means at the outlet end of the hollow piston, the external diameter of the hollow piston at its end being greater than the base diameter of the groove or the external diameter of the taper and less than the diameter of the cylinder, or
  - several, preferably two, diametrically opposite points at the outlet end

of the hollow piston with flattened surfaces and a step acting as stop means.

4. A device according to claim 1, including  
a hollow piston having an inwardly shaped edge at the outlet end of the hollow piston to act as stop means,  
a cylindrical valve member which is guided and mounted in axially movable manner directly in front of the outlet end of the hollow piston,  
a coaxial undercut peg on the valve member, and  
a defined sealing surface which rests on the shaped edge at the outlet end of the hollow piston.
5. A device according to claim 1, 2 or 4, including  
a cylindrical valve member the diameter of which is less than the internal diameter of the cylinder or  
a cylindrical valve member the diameter of which is equal to the internal diameter of the cylinder, and at least one channel extending in the axial direction of the valve member, preferably on the outer surface of the valve member.
6. A device according to claim 1, including  
a cylindrical hollow piston having a widened portion at one end, the inner diameter of which is greater than the inner diameter in the remainder of the hollow piston,  
an inwardly shaped edge of the hollow piston,  
a valve member which is guided and mounted in axially movable manner inside the hollow piston in the widened portion thereof, the maximum diameter of the valve member being less than the internal diameter of the hollow piston in its widened portion and greater than the internal diameter in

the remainder of the hollow piston,

at least one recess in the region of the outlet end of the valve member,  
a defined sealing surface located inside the hollow piston at the inlet  
end of the valve member.

7. A device according to claim 6, including

a cylindrical hollow piston having a widened portion at the outlet end  
of the hollow piston,

an inwardly shaped edge at the outlet end of the hollow piston as a stop  
means,

at least one recess in the valve member at the outlet end thereof, or  
at least one recess in the stop means of the hollow piston.

8. A device according to claim 6, including

a cylindrical hollow piston having a widened portion at the inlet end  
of the hollow piston,

an inwardly shaped edge at the inlet end of the hollow piston as a  
defined sealing surface,

a stop means at the outlet end of the widened portion of the hollow  
piston,

at least one recess in the valve member at the outlet end thereof, or  
at least one recess in the stop means of the hollow piston.

9. A device according to claim 1, including

a cylindrical hollow piston having an inwardly shaped edge at one end  
of the hollow piston,

an encircling constriction near the shaped edge of the hollow piston,

a valve member which is guided and mounted in axially movable

manner inside the hollow piston between the shaped edge and the encircling constriction, the maximum diameter of the valve member being less than the internal diameter of the hollow piston,

a recess in the region of the outlet end of the valve member,

a defined sealing surface which is located inside the hollow piston at the inlet end of the valve member.

10. A device according to claim 9, including

a cylindrical hollow piston having an inwardly shaped edge at the outlet end of the hollow piston as a stop means,

an encircling constriction in the region of the shaped edge at the outlet end of the hollow piston,

at least one recess in the valve member at the outlet end thereof, or  
at least one recess in the stop means of the hollow piston.

11. A device according to claim 9, including

a cylindrical hollow piston having an inwardly shaped edge at the inlet end of the hollow piston as a defined sealing surface,

an encircling constriction in the vicinity of the shaped edge at the inlet end of the hollow piston as a stop means,

at least one recess in the valve member at the outlet end thereof, or  
at least one recess in the stop means of the hollow piston.

12. A device according to claim 1, including

a cylindrical hollow piston,

a first encircling constriction at a spacing from the outlet end of the hollow piston as a stop means,

a second encircling constriction between the first constriction and the

inlet end of the hollow piston as a defined sealing surface,

a valve member which is guided and mounted in axially movable manner between the two constrictions.

13. A device according to claim 1, 6 or 12, including  
a preferably cylindrical valve member having at least one recess in the  
valve member at the outlet end thereof, or

a preferably cylindrical valve member and at least one recess in the  
stop means of the hollow piston.

14. A device according to claim 1, 9 or 12, including  
a displacement body having an axially extending channel, which is  
arranged in the inlet end of the hollow piston and fixedly connected to the  
hollow piston and preferably extends as far as the encircling constriction  
which is closest to the inlet end of the hollow piston.

15. A device according to claim 1, 9 or 12, including  
a displacement body having an axially extending channel, which is  
mounted in the outlet end of the hollow piston and is fixedly connected to the  
hollow piston and preferably extends as far as the encircling constriction  
which is closest to the outlet end of the hollow piston.

16. A device according to claim 1, including  
a cylindrical hollow piston having a widened portion at the entry end  
and optionally a tube as the displacement body in the unwidened part of the  
hollow piston,  
a closure member connected to the widened end of the hollow piston  
and containing a flat or conical depression with a bore,

a valve member which is guided and mounted in axially movable manner in the depression, and which is optionally provided at the outlet end with a slot as recess or a notch,

a stop means in the region of the outlet end of the valve member and a defined sealing surface at the inlet end of the valve member.

17. An atomiser for atomising a fluid, comprising an upper housing part, a lower housing part, a spring housing, a spring, a pump housing, a nozzle, a blocking mechanism and a storage container, the atomiser including

a pump housing fixed in the upper housing part and having at one end a nozzle member with the nozzle,

a hollow piston with a valve member,

a drive flange in which the hollow piston is secured and which is located in the upper housing part,

a blocking or latching mechanism arranged in the upper housing part,

a spring housing with the spring located therein, which is rotatably mounted on the upper housing part by means of a rotary bearing,

a lower housing part which can be fitted onto the spring housing in the axial direction.

18. An atomiser for atomising a fluid, comprising an upper housing part, a lower housing part, a spring housing, a spring, a pump housing, a nozzle, a blocking mechanism and a storage container, the atomiser including

a pump housing fixed in the upper housing part and having at one end a nozzle member with the nozzle,

a hollow piston with a valve member according to any one of claims 1 to 16, which optionally projects partly into the cylinder of the pump housing and is optionally mounted in axially movable manner in the cylinder,

a drive flange in which the hollow piston is secured and which is located in the upper housing part,

a blocking or latching mechanism arranged in the upper housing part,

a spring housing with the spring located therein, which is rotatably mounted on the upper housing part by means of a rotary bearing,

a lower housing part which can be fitted onto the spring housing in the axial direction.

19. An atomiser according to claim 17 or 18, comprising

a blocking mechanism in the form of a helical thrust gear, with a blocking member arranged in annular configuration with engaging locking surfaces and an actuating button.

20. An atomiser according to any one of claims 17 to 19, comprising

a mechanical counter having a spindle and a slide, which is mounted on the spring housing in the region of the outer surface, and the axis of which runs parallel to the axis of the spring housing.

21. An atomiser according to any one of claims 17 to 20, comprising

a nozzle member comprising two glass and/or silicon plates firmly joined together, at least one plate having one or more microstructured channels which connect the nozzle inlet end to the nozzle outlet end, and the nozzle outlet end has at least one opening less than or equal to 10  $\mu\text{m}$  in size (hydraulic diameter).

22. An atomiser according to claim 21, comprising

a nozzle member having at least two nozzle openings at the outlet end, the directions of spraying being inclined relative to one another and meeting

in the vicinity of the nozzle openings.

23. An atomiser according to any one of claims 17 to 22, comprising a non-return valve mounted in the pump housing between the nozzle opening and high pressure chamber of the cylinder.
24. An atomiser according to any one of claims 17 to 23, comprising a hollow piston which exerts a pressure of 5 to 60 MPa (about 50 to 600 bar) on the fluid at its end facing the nozzle (high pressure end) at the moment of actuation of the spring.
25. An atomiser according to claim 24, comprising a hollow piston (57) which exerts a pressure of 10 to 60 MPa (about 100 to 600 bar) on the fluid at its end facing the nozzle (high pressure end) at the moment of actuation of the spring (68).
26. An atomiser according to any one of claims 17 to 25, comprising a replaceable storage container for the fluid arranged in the lower housing part.
27. A storage container for a fluid, containing a pharmaceutical composition, for use in an atomiser according to any one of claims 17 to 26.
28. Use of the atomiser according to any one of claims 17 to 27 for producing medicinal aerosols without propellant gas.
29. A storage container according to claim 27, containing a pharmaceutically acceptable solution of a medicament selected from the group

comprising: berotec, berodual, flunisolide, atrovent, salbutamol, budesonide, combivent, tiotropium, oxivent and suitable peptides.

30. An atomiser for spraying liquid at high pressure comprising a pump for pressurising a predetermined volume of liquid and discharging it through an atomising nozzle, the pump comprising a cylinder, a piston reciprocable therein, the piston being tubular and providing an inlet flow path to the cylinder beyond a first end of the piston and being provided with a non-return valve, a liquid reservoir having a top surface, membrane, stopper or cap of resilient material penetrated by the other end of the piston to permit liquid flow from the reservoir through the length of the piston into the cylinder on the induction stroke, the piston and the reservoir being fixed relative to each other when the pump is operated, and a pump reciprocating means for moving the piston and cylinder relatively to each other.
31. An atomiser according to claim 30, wherein the second end of the piston is pointed for initial penetration of the resilient top surface, membrane, stopper or cap of the reservoir.
32. An atomiser according to claim 31, wherein the pump reciprocating means comprises a spring-loaded flange or other member on the piston, such that the spring operates the pump in the compression direction, and means for tensioning the spring when the pump operates in the induction direction.
33. An atomiser according to claim 32, wherein the means for tensioning comprises a helical saw tooth cam operated by rotating one part of the atomiser relative to another part.
34. An atomiser according to claim 32 or 33, wherein the pump reciprocating means comprises a manually operable latch for temporarily

holding the spring in its loaded condition prior to discharge of pressurised fluid.

35. An atomiser according to any one of claims 30-34 which is adapted to pressurise liquid to a pressure of at least 50 bar.-

36. An atomiser according to any one of claims 17-26 which is a metered dose inhaler for producing a mist of liquid medicament for inhalation into the lungs, the liquid droplets having a mass mean size of not more than 12 micrometres.

37. A reciprocating pump device for producing high pressure in a fluid, comprising a cylinder, a hollow cylindrical piston which is movable in the cylinder and provides a path for fluid therethrough, a high pressure chamber which is located in front of the piston inside the cylinder and which is supplied with fluid through said path, and an inlet non-return valve member in said fluid path which moves with the piston but is capable of limited guided movement along the piston axis between a closed position in contact with a valve seat provided by the piston and an open position spaced from the valve seat, the valve member being so shaped and guided that it cannot rotate about an axis transverse to the piston axis such that a predetermined surface thereof engages the seat.

38. A device according to claim 37, wherein the valve member is generally cylindrical and is mounted in the hollow piston front end, the effective area of the valve seat being substantially the same as that of the piston bore.

39. A device according to claim 38, wherein the valve seat is frustoconical.

40. An atomiser according to any one of Claims 30-36 incorporating a device according to any one of 37-39.
41. An atomiser according to any one of Claims 17-26, 30-36 and 40, having a nozzle and a filter upstream of the nozzle.